ORIGINATION FORM
Proposed Revisions to the Specifications
(Please provide all information - incomplete forms will be returned)

Date: 5/3/2021

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Office: Structures Design

Specification Section: 933

Article/Subarticle: 1 & 5

Associated Section(s) Revisions: none

Will the proposed revision require changes to:

Publication	Yes	No	Office Staff Contacted
Standard Plans Index	○	○	Cheryl Hudson, Josh Turley
Traffic Engineering Manual	○	○	None
FDOT Design Manual	○	○	None
Construction Project Administration Manual	○	○	John Westphal
Basis of Estimate/Pay Items	○	○	None
Structures Design Guidelines	○	○	Ben Goldsberry
Approved Product List	○	○	None
Materials Manual	○	○	Chase Knight, Jose Arment

Will this revision necessitate any of the following:

Design Bulletin ☐ **Construction Bulletin** ☐ **Estimates Bulletin** ☐ **Materials Bulletin** ☐

Are all references to external publications current? **Yes** ◉ **No** ○

If not, what references need to be updated? (Please include changes in the redline document.)

None

Why does the existing language need to be changed?

Update HSSS strands to new ASTM publication
Clarification of Elastic Modulus for CFRP Strand acceptance minimum threshold compared to CFRP Bars.
Reinstate 19.3mm CFRP strand size needed for optional pile splicing material

Summary of the changes:

Delete Table 1, now in ASTM A1114
Add 19.3mm CFRP Strand in Table 2
Add special Shipping and Storage requirements in new subsection for CFRP.
Add Minimum Elastic Modulus for CFRP strand added to Tables 2 & 4 to distinguish from

Are these changes applicable to all Department jobs? **Yes** ◉ **No** ○

If not, what are the restrictions?

Contact the State Specifications Office for assistance in completing this form.
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M E M O R A N D U M

DATE: June 3, 2021

TO: Specification Review Distribution List

FROM: Daniel Strickland, P.E., State Specifications Engineer

SUBJECT: Proposed Specification: **9330100 PRESTRESSING STRAND AND BAR.**

In accordance with Specification Development Procedures, we are sending you a copy of a proposed specification change.

The changes are proposed by Steve Nolan to update tables and add special shipping and storage requirements in the new subarticle for Carbon-Fiber-Reinforced-Polymer.

Please share this proposal with others within your responsibility. Review comments are due within four weeks and should be sent to Mail Station 75 or online at http://fdotewp1.dot.state.fl.us/programmanagement/development/industryreview.aspx . Comments received after **July 1, 2021** may not be considered. Your input is encouraged.

DS/dh

Attachment

PRESTRESSING STRAND AND BAR
(REV 5-3-21)

ARTICLE 933-1 is deleted and the following substituted:

933-1 Strands for Prestressing.

933-1.1 Carbon ~~-~~Steel Strands for Prestressing: The carbon-steel strands for prestressing concrete members shall be Grade 270, low-relaxation seven wire strand ~~and shall~~ conforming to the requirements of ASTM A416.

933-1.2 Stainless-Steel Strands for Prestressing: The stainless-steel strands for prestressing concrete members shall be a high strength stainless-steel (HSSS, Grade 240)~~-~~, low-relaxation seven wire strand conforming to the ~~chemical~~ requirements of ASTM ~~A276~~ A1114.~~, UNS S31803 or S32205 (Type 2205). The mechanical and dimensional requirements shall follow the requirements of ASTM A416 except as modified by this Section. The breaking strength shall conform to the requirements of Table 933-1. The minimum yield strength shall be 85% of the breaking strength listed in Table 933-1. The total elongation under load shall not be less than 1.4%. Stainless-steel strand shall conform to a size tolerance of +0.026 in., -0.006 in. from the nominal diameter measured across the crowns of the wires.~~

~~Table 933-1~~
~~Breaking Strength Requirements of Stainless-Steel Strand~~

~~Nominal Diameter (in)~~	~~Nominal Cross Sectional Area (in^2)~~	~~Minimum Breaking Strength (kips)~~	~~Nominal Ultimate Tensile Stress (ksi)~~
~~0.52~~	~~0.167~~	~~40.1~~	~~240~~
~~0.62~~	~~0.231~~	~~55.4~~	~~240~~

933-1.3 Carbon-Fiber-Reinforced Polymer (CFRP) Strands for Prestressing: Obtain CFRP prestressing strands from producers currently on the Department's Production Facility Listing. Producers seeking inclusion on the list shall meet the requirements of Section 105. CFRP strand shall meet the requirements of this Section.

Table 933-2
Typical Sizes and Loads of CFRP Prestressing Strands and Bars

Type	Nominal Diameter (in)	Nominal Cross Sectional Area (in^2)	Nominal Ultimate Load (P_u) (kips)	Nominal Ultimate Tensile Stress (ksi)
Single Strand - 5.0mm Ø	0.20	0.025	9.1	364
7-strand - 7.9mm Ø	0.31	0.048	17.8	370
7-strand - 10.8mm Ø	0.43	0.090	33.1	367
Single Strand (Bar) - 9.5mm Ø	0.38	0.110	35.0	318
7-strand - 12.5mm Ø	0.49	0.117	43.3	370
Single Strand (Bar) - 12.7mm Ø	0.50	0.196	59.0	301
7-strand - 15.2mm Ø	0.60	0.179	66.2	369

7-strand - 17.2mm Ø	0.68	0.234	86.6	370
7-strand – 19.3mm Ø	0.76	0.289	106.9	370

ARTICLE 933-1 is expanded by the following new subarticle:

933-1.4 Shipping and Storage: Protect carbon-steel, stainless-steel, and CFRP strands for prestressing against mechanical damage and contamination during shipping and storage.

SUBARTICLE 933-5.2 is deleted and the following substituted:

933-5.2 Strands:

933-5.2.1 Steel Strands: Acceptance of carbon-steel and stainless-steel prestressing strands shall be based on samples taken by the Department and the producer's certified mill analysis certifying that the test results meet the specification limits of ASTM, AASHTO, or FDOT as specifically designated. Prior to use, submit to the Engineer the producer's certified mill analysis for each heat or production LOT per shipment of strand.

Certifi~~cations~~ed mill analyses for steel prestressing strand shall contain, for each heat number or production LOT, all test results required by ASTM A416 and ASTM A1114. Include the modulus of elasticity expressed in psi or the stress-strain curve with units identified.

The Engineer will select samples and certified mill analysis representing each shipment at a frequency of one sample per producer, per size of strand, per shipment.

933-5.2.2 Carbon-Fiber-Reinforced Polymer (CFRP) Strands: Producers shall submit to the State Materials Office (SMO), a test report of the physical and mechanical property requirements in Table 933-3. Qualification testing shall be conducted by an independent laboratory approved by the Department for performing the FRP test methods. Three production LOTS shall be randomly sampled at the production facility by a designee of the SMO. The minimum number of specimens per production LOT shall be as indicated in Table 933-3. The coefficient of variation (COV) for each test result shall be less than 6%. Outliers shall be subject to further investigation in accordance with ASTM E178. If the COV exceeds 6%, the number of test specimens per production LOT may be doubled a maximum of two times, to meet the COV requirement. Otherwise, the results shall be rejected. A production LOT is defined as a LOT of CFRP strand produced from start to finish with the same constituent materials used in the same proportions without changing any production parameter, such as cure temperature or line speed.

Table 933-3 Physical and Mechanical Property Requirements for CFRP Prestressing Strands			
Property	Test Method	Requirement	Specimens per LOT
Fiber Mass Fraction	ASTM D2584 or ASTM D3171	≥70%	10
Short-Term Moisture Absorption	ASTM D570, Procedure 7.1; 24 hours immersion at 122°F	≤0. 25%	10
Long-Term Moisture Absorption	ASTM D570, Procedure 7.4; immersion to full saturation at 122°F	≤1.0%	10
Glass Transition Temperature (T_g)	ASTM D7028 (DMA) or ASTM E1356 (DSC; T_m)/ASTM D3418 (DSC; T_{mg})	≥230°F ≥212°F	3
Total Enthalpy of Polymerization (Resin)	ASTM E2160	Identify the resin system used for each bar size and report the average value of three replicates for each system	-
Degree of Cure	ASTM E2160	≥95% of Total polymerization enthalpy	3
Measured Cross Sectional Area	ASTM D7205	Within -5% to +10% of nominal values listed in Table 933-2	10
Ultimate Tensile Strength (UTS)		≥ Value listed in Table 933-2	
Tensile Modulus		≥18,000 ksi for Bar; > 22,400 ksi for 7-strand & 5mm Ø.	
Alkali Resistance with Load	ASTM D7705, 3 months test duration at 140 ± 5°F. Apply sustained tensile stress to induce 3000 micro-strain, followed by tensile test per ASTM D7205	Tensile strength retention ≥70% of UTS	5
Creep Rupture Strength	ASTM D7337, 3 months test duration at laboratory conditions. Apply sustained tensile load equivalent to 75% UTS, followed by tensile test per ASTM D7205	Equivalent sustained load ≥75% UTS AND Tensile strength retention ≥90% UTS	3

933-5.2.2.1 Material Acceptance: Submit to the Engineer a certificate of analysis for each production LOT from the producer of the CFRP strand, confirming compliance with the requirements of this Section.

933-5.2.2.2 Sampling: The Engineer will select a minimum total of 42 feet from each shipment, representing a random production LOT, per size of CFRP strand for testing in accordance with Table 933-4. The minimum discrete sample length shall be 7 feet. Testing shall be conducted, at the Contractor's expense, by a Department approved independent laboratory. Each test shall be replicated a minimum of three times per sample. Submit the test results to the Engineer for review and approval prior to installation.

Table 933-4
Testing requirements for Project Material Acceptance of CFRP Prestressing Strand

Property	Test Method	Requirement
Fiber Mass Fraction	ASTM D2584 or ASTM D3171	≥70%
Short-Term Moisture Absorption	ASTM D570, Procedure 7.1; 24 hours immersion at 122°F	≤0.25%
Glass Transition Temperature	ASTM D7028 (DMA) or ASTM E1356 (DSC; T_m)/ASTM D3418 (DSC; T_{mg})	≥230°F ≥212°F
Degree of Cure	ASTM E2160	≥95% of Total polymerization enthalpy
Actual Cross Sectional Area	ASTM D7205	Within -5% to +10% of nominal values listed in Table 933-2
Ultimate Tensile Strength		≥ Value listed in Table 933-2
Tensile Modulus		≥18,000 ksi for Bar; > 22,400 ksi for 7-strand & 5mm Ø